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Description

RELATED APPLICATIONS

This Application is related to U.S. Patent No. 5 053 962 (& EP-A-0 404 387), titled AUTOMATIC SHIFT PRESELECTION MODE FOR MECHANICAL TRANSMISSION SYSTEM WITH SEMI-AUTOMATIC SHIFT IMPLEMENTATION; Patent No. 5 053 961 (& EP-A-404 353), titled SEMI-AUTOMATIC SHIFT IMPLEMENTATION FOR MECHANICAL TRANSMISSION SYSTEM; Patent No. 5 053 959 (& EP-A-404 354) titled CONTROL SYSTEM AND METHOD FOR SENSING AND INDICATING NEUTRAL IN A SEMI-AUTOMATIC MECHANICAL TRANSMISSION SYSTEM; and Patent No. 5 063 511 (& EP-A-413 412) titled ENHANCED MISSED SHIFT RECOVERY FOR SEMI-AUTOMATIC SHIFT IMPLEMENTATION CONTROL SYSTEM; all assigned to Eaton Corporation.

This application is also related to U.S. Patent No. 5 050 079 (& EP-A-0 471 491) entitled MODE CONTROL FOR MECHANICAL TRANSMISSION SYSTEM WITH SEMI-AUTOMATIC SHIFT IMPLEMENTATION AND MANUAL AND AUTOMATIC SHIFT PRESELECTION MODES, assigned to Eaton Corporation.

This application is related to, and is a Continuation-In-Part of, copending allowed U.S. Patent No. 5 089 962 (& EP-A-0 473 298) entitled UNEXPECTED N LOGIC, assigned to Eaton Corporation.

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to vehicular semi-automatic mechanical transmission systems and, in particular, to semi-automatic mechanical transmission systems of the type providing partially automatic implementation, including an automatic shift into neutral upon a driveline torque break or torque reversal condition, of preselected shifts and having at least one automatic preselect mode of operation wherein ratio changes are automatically preselected by the system central processing unit.

More particularly, the present invention relates to semi-automatic transmission systems of the type described above wherein, in the operator selected automatic preselection mode of operation, if vehicle speed (output shaft speed) remains substantially constant (i.e. if, for upshift conditions, output shaft acceleration does not exceed a first reference value, or, for downshift conditions, output shaft deceleration does not exceed a second reference value) then automatic preselection of shifts and automatic shifts into sustained neutral are prevented to prevent unexpected/undesired transmission shifts into sustained transmission neutral.

Still more particularly, the present invention relates to semi-automatic transmission systems of the type described above wherein, if engine or input shaft speeds are between certain values, the values of the first and second reference values will vary as a function of engine or input shaft speed.

Description of the Prior Art

Fully automatic transmission systems, both for heavy-duty vehicles such as heavy-duty trucks, and for automobiles, that sense throttle openings or positions, vehicle speeds, engine speeds, and the like, and automatically shift the vehicle transmission in accordance therewith, are well known in the prior art. Such fully automatic change gear transmission systems include automated transmissions wherein pressurized fluid is utilized to frictionally engage one or more members to other members or to a ground to achieve a selected gear ratio as well as automated mechanical transmissions utilizing electronic, hydraulic, and/or pneumatic logic and actuators to engage and disengage mechanical (i.e. positive) clutches to achieve a desired gear ratio. Examples of such transmissions may be seen by reference to U.S. Pat. Nos. 3,961,546; 4,081,065; 4,361,060 and 4,551,802.

Such fully automatic change gear transmissions can be unacceptably expensive, particularly for the largest heavy-duty vehicles which are not typically sold in high volumes. Additionally, those automatic change gear transmissions utilizing pressurized fluid and/or torque converters tend to be relatively inefficient in terms of power dissipated between the input and output shafts thereof.

Semi-automatic transmission systems utilizing electronic control units which sense throttle position, engine, input shaft, output shaft and/or vehicle speed, and utilize automatically controlled fuel throttle devices, gear shifting devices and/or master clutch operating devices to substantially fully automatically implement operator manually selected transmission ratio changes are known in the prior. Examples of such semi-automatic transmission systems may be seen by reference to U.S. Pat. Nos. 4,425,620; 4,631,679 and 4,648,290.

While such semi-automatic mechanical transmission systems are very well received as they are somewhat less expensive than fully automatic transmission systems, allow manual clutch control for low speed operation and/or do not require automatic selection of the operating gear ratio, they may be too expensive for certain applications as a relatively large number of sensors and automatically controllable actuators, such as a master clutch and/or a fuel throttle device actuator, are required to be provided, installed and maintained.

Many of the drawbacks of the prior art are overcome or minimized by the previous provision of a semi-automatic shift implementation system/method for a mechanical transmission system for use in vehicles having a manually or partially automatically controlled engine throttle means, and a manually only controlled master clutch. The system has, preferably, a manual preselection mode wherein shifts are manually preselected and at least one mode of operation wherein the shifts to be semi-automatically implemented are automatically preselected and includes a control/display panel or console for operator selection of operation in the automatic preselection mode and indication of automatic preselection of upshifts, downshifts or shifts into neutral. An electronic control unit (ECU) is provided for receiving input signals indicative of transmission input and output shaft speeds and for processing same in accordance with predetermined logic rules to determine, in the automatic preselection mode, if an upshift or downshift from the currently engaged ratio is required and to issue command output signals to a transmission actuator for shifting the transmission in accordance with the command output signals.

The control/display device will display the selected but not yet implemented shift as well as the current status of the transmission, and, preferably will allow the operator to select/preselect a shift into a higher ratio, a lower ratio or into neutral. Preferably, the control device will also allow a manually or an automatically preselected shift to be cancelled.

In both the manual and the automatic preselection modes, when a ratio change is manually or automatically preselected, the transmission will automatically be urged or biased to shift, upon a driveline torque break or reversal, to neutral and will then shift to the selected ratio only upon the operator manually causing a substantially synchronous condition to exist.

In accordance with the previously proposed control, a control system/method for a vehicular semi-automatic mechanical transmission system for partially automatic implementation of manually and automatically preselected transmission shifts was provided which did not require throttle or clutch actuators, and which required only two speed signal inputs. However, this system was not totally satisfactory as, after a long period of relatively stable vehicle operating conditions, i.e. vehicle speed substantially constant or changing at less than a predetermined rate, an automatic preselection of automatic shifting of the transmission into, and remaining in, neutral may be undesired, unexpected and/or startling to the operator. This can occur during unintended torque breaks caused by cresting a hill, bumps in the road, and similar occurrences. EP-A-0 410 593 discloses the pre-characterizing portion of Claims 1 and 5.

SUMMARY OF THE INVENTION

In accordance with features preferred in the present invention, which is itself alternatively defined in Claims 1 and 5, a control system/method which minimizes or eliminates the drawback of unexpected/undesired shifting into and remaining in neutral of the previously proposed control system/method for a vehicular system for partially automatic implementation of automatically selected transmission shifts, which does not require an automatic clutch or throttle actuator, and which requires only two or more speed signal inputs, is provided.

The above is accomplished, in the previously proposed control system/method, by monitoring vehicle (output shaft) speed and, if the vehicle speed remains substantially constant or changes at less than a predetermined rate, then the control will not be permitted to automatically preselect upshifts and downshifts from the currently engaged transmission ratio. Preferably, the rate, i.e. the reference output shaft acceleration/deceleration is, between limits of input shaft speeds, a function of current input shaft speed.

This and other objects and advantages of the present invention will become apparent from a reading of the detailed description of the preferred embodiment taken in connection with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic illustration of the vehicular mechanical transmission system partially automated by the system of the present invention.

Figure 1A is a schematic illustration of the shift pattern of the transmission of Figure 1.

Figure 2 is a schematic illustration of the automatic preselect and semi-automatic shift implementation system for a mechanical transmission system of the present invention.

Figure 3 is a schematic illustration of an alternate control console for the system of Figure 2.

Figure 4 is a schematic illustration, in the form of a flow chart, of the enhanced control system/method of the present invention.

Figure 5 is a graphical illustration of the enhanced control system/method of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Certain terminology will be used in the following description for convenience in reference only

and will not be limiting. The words "upwardly", "downwardly", "rightwardly", and "leftwardly" will designate directions in the drawings to which reference is made. The words "forward", "rearward", will refer respectively to the front and rear ends of the transmission as conventionally mounted in a vehicle, being respectfully from left and right sides of the transmission as illustrated in Figure 1. The words "inwardly" and "outwardly" will refer to directions toward and away from, respectively, the geometric center of the device and designated parts thereof. Said terminology will include the words above specifically mentioned, derivatives thereof and words of similar import.

The term "compound transmission" is used to designate a change speed or change gear transmission having a multiple forward speed main transmission section and a multiple speed auxiliary transmission section connected in series whereby the selected gear reduction in the main transmission section may be compounded by further selected gear reduction in the auxiliary transmission section. "Synchronized clutch assembly" and words of similar import shall designate a clutch assembly utilized to nonrotatably couple a selected gear to a shaft by means of a positive clutch in which attempted engagement of said clutch is prevented until the members of the clutch are at substantially synchronous rotation in a relatively large capacity friction means are utilized with the clutch members and are sufficient, upon initiation of a clutch engagement, to cause the clutch members and all members rotating therewith to rotate at substantially synchronous speed.

The term "upshift" as used herein, shall mean the shifting from a lower speed gear ratio into a higher speed gear ratio. The term "downshift" as used herein, shall mean the shifting from a higher speed gear ratio to a lower speed gear ratio. The terms "low speed gear", "low gear" and/or "first gear" as used herein, shall all designate the gear ratio utilized for lowest forward speed operation in a transmission or transmission section, i.e., that set of gears having the highest ratio of reduction relative to the input shaft of the transmission.

A "selected direction" of shifting will refer to selection of either single or multiple upshifting or downshifting from a particular gear ratio.

Referring to Figure 1, a range type compound transmission 10 of the type partially automated by the enhanced semi-automatic mechanical transmission system/method of the present invention is illustrated. Compound transmission 10 comprises a multiple speed main transmission section 12 connected in series with a range type auxiliary section 14. Transmission 10 is housed within a housing H and includes an input shaft 16 driven by a prime mover such as diesel engine E through a selectively disengaged, normally engaged friction master clutch C having an input or driving portion 18 drivingly connected to the engine crankshaft 20 and a driven portion 22 rotatably fixed to the transmission input shaft 16.

The engine E is fuel throttle controlled by a manually controlled throttle device (not shown) and the master clutch C is manually controlled by a clutch pedal (not shown) or the like. Preferably, the engine E will have known characteristics such as maximum and minimum rated speeds and the like. An input shaft brake B, operated by over-travel depression of the clutch pedal, is preferably provided to provide quicker upshifting as is well known in the prior art.

Transmissions similar to mechanical transmission 10 are well known in the prior art and may be appreciated by reference to U.S. Pat. Nos. 3,105,395; 3,283,613 and 4,754,665.

In main transmission section 12, the input shaft 16 carries an input gear 24 for simultaneously driving a plurality of substantially identical countershaft assemblies 26 and 26A at substantially identical rotational speeds. The two substantially identical countershaft assemblies are provided on diametrically opposite sides of mainshaft 28 which is generally coaxially aligned with the input shaft 16. Each of the countershaft assemblies comprises a countershaft 30 supported by bearings 32 and 34 in housing H, only a portion of which is schematically illustrated. Each of the countershafts is provided with an identical grouping of countershaft gears 38, 40, 42, 44, 46 and 48, fixed for rotation therewith. A plurality of mainshaft gears 50, 52, 54, 56 and 58 surround the mainshaft 28 and are selectively clutchable, one at a time, to the mainshaft 28 for rotation therewith by sliding clutch collars 60, 62 and 64 as is well known in the prior art. Clutch collar 60 may also be utilized to clutch input gear 24 to mainshaft 28 to provide a direct drive relationship between input shaft 16 and mainshaft 28.

Typically, clutch collars 60, 62 and 64 are axially positioned by means of shift forks associated with the shift housing assembly 70, as well known in the prior art. Clutch collars 60, 62 and 64 may be of the well known acting nonsynchronized double acting jaw clutch type.

Shift housing or actuator 70 is actuated by compressed fluid, such as compressed air, and is of the type automatically controllable by a control unit as may be seen by reference to U.S. Pat. Nos. 4,445,393; 4,555,959; 4,361,060; 4,722,237 and 2,931,237.

Mainshaft gear 58 is the reverse gear and is in continuous meshing engagement with countershaft gears 48 by means of conventional intermediate idler gears (not shown). It should also be noted that

while main transmission section 12 does provide five selectable forward speed ratios, the lowest forward speed ratio, namely that provided by drivingly connecting mainshaft drive gear 56 to mainshaft 28, is often of such a high gear reduction it has to be considered a low or "creeper" gear which is utilized only for starting of a vehicle under severe conditions and, is not usually utilized in the high transmission range. Accordingly, while main transmission section 12 does provide five forward speeds, it is usually referred to as a "four plus one" main section as only four of the forward speeds are compounded by the auxiliary range transmission section 14 utilized therewith.

Jaw clutches 60, 62, and 64 are three-position clutches in that they may be positioned in the centered, nonengaged position as illustrated, or in a fully rightwardly engaged or fully leftwardly engaged position by means of actuator 70. As is well known, only one of the clutches 60, 62 and 64 is engageable at a given time and main section interlock means (not shown) are provided to lock the other clutches in the neutral condition.

Auxiliary transmission range section 14 includes two substantially identical auxiliary countershaft assemblies 74 and 74A, each comprising an auxiliary countershaft 76 supported by bearings 78 and 80 in housing H and carrying two auxiliary section countershaft gears 82 and 84 for rotation therewith. Auxiliary countershaft gears 82 are constantly meshed with and support range/output gear 86 while auxiliary section countershaft gears 84 are constantly meshed with output gear 88 which is fixed to transmission output shaft 90.

A two-position synchronized jaw clutch assembly 92, which is axially positioned by means of a shift fork (not shown) and the range section shifting actuator assembly 96, is provided for clutching either gear 86 to mainshaft 28 for low range operation or gear 88 to mainshaft 28 for direct or high range operation of the compound transmission 10. The "shift pattern" for compound range type transmission 10 is schematically illustrated in Figure 1A.

Range section actuator 96 may be of the type illustrated in U.S. Pat. Nos. 3,648,546; 4,440,037 and 4,614,126.

Although the range type auxiliary section 14 is illustrated as a two-speed section utilizing spur or helical type gearing, it is understood that the present invention is also applicable to range type transmissions utilizing combined splitter/range type auxiliary sections, having three or more selectable range ratios and/or utilizing planetary type gearing. Also, any one or more of clutches 60, 62 or 64 may be of the synchronized jaw clutch type and transmission sections 12 and/or 14 may be of the single countershaft type.

For purposes of providing a manual preselect mode of operation and the automatic preselect mode of operation, and the semi-automatic shift implementation operation of transmission 10, an input shaft speed sensor and an output shaft speed sensor 100 are utilized. Alternatively to output shaft speed sensor 100, a sensor 102 for sensing the rotational speed of auxiliary section countershaft gear 82 may be utilized. The rotational speed of gear 82 is, of course, a known function of the rotational speed of mainshaft 28 and, if clutch 92 is engaged in a known position, a function of the rotational speed of output shaft 90. During running conditions, when clutch C is not slipping, the speed of input shaft 16 will be equal to the speed of engine E.

The manual and automatic preselect and semi-automatic shift implementation control system 104 for a mechanical transmission system of the present invention is schematically illustrated in Figure 2. Control system 104, in addition to the mechanical transmission system 10 described above, includes an electronic control unit 106, preferably microprocessor based, for receiving input signals from the input shaft speed sensor 98, from the output shaft speed sensor 100 (or, alternatively, the mainshaft speed sensor 102) and from the driver control console 108. The ECU 106 may also receive inputs from an auxiliary section position sensor 110.

The ECU is effective to process the inputs in accordance with predetermined logic rules to issue command output signals to a transmission operator, such as solenoid manifold 112 which controls the mainsection section actuator 70 and the auxiliary section actuator 96, and to the driver control console 108. ECUs of this type are known in the prior art as may be seen by reference to U.S. Patent No. 4,595,986.

In the preferred embodiment, the driver control console allows the operator to manually select a shift in a given direction or to neutral from the currently engaged ratio, or to select a semi-automatic preselect mode of operation, and provides a display for informing the operator of the current mode of operation (automatic or manual preselection of shifting), the current transmission operation condition (forward, reverse or neutral) and of any ratio change or shift (upshift, downshift or shift to neutral) which has been preselected but not yet implemented.

Console 108 includes three indicator lights 114, 116 and 118 which will be lit to indicate that the transmission 10 is in a forward drive, neutral or reverse drive, respectively, condition. The console also includes three selectively lighted pushbuttons 120, 122, and 124 which allow the operator to select an upshift, the automatic preselection mode

or a downshift, respectively. A pushbutton 126 allows selection of a shift into neutral.

A selection made by depressing or pushing any one of buttons 120, 122, 124 or 126 and may be cancelled (prior to execution in the case of buttons 120, 124 and 126) by redepressing the buttons. As an alternative, multiple depressions of buttons 120 and 124 may be used as commands for skip shifts. Of course, the buttons and lighted buttons can be replaced by other selection means, such as a toggle switch and/or a toggle switch and light or other indicia member. A separate button or switch for selection of reverse may be provided or reverse may be selected as a downshift from neutral. Also, neutral may be selected as an upshift from reverse or as a downshift from low.

In operation, to select upshifts and downshifts manually, the operator will depress either button 120 or button 124 as appropriate. The selected button will then be lighted until the selected shift is implemented or until the selection is cancelled.

Alternatively, at a given engine speed (such as above 1700 RPM) the upshift button may be lit and remain lit until an upshift is selected by pushing the button.

To implement a selected shift, the manifold 112 is preselected to cause actuator 70 to be biased to shift main transmission section 12 into neutral. This is usually accomplished by a naturally occurring torque reversal in the vehicle drive train or the operator causing a torque reversal by manually momentarily decreasing and/or increasing the supply of fuel to the engine and/or manually disengaging the master clutch C. As the transmission is shifted into neutral, and neutral is verified by the ECU (neutral sensed for a period of time such as 1.5 seconds), the neutral condition indicia button 116 is lighted. If the selected shift is a compound shift, i.e. a shift of both the main section 12 and of the range section 14, such as a shift from 4th to 5th speeds as seen in Figure 1A, the ECU will issue command output signals to manifold 112 to cause the auxiliary section actuator 96 to complete the range shift after neutral is sensed in the front box.

When the range auxiliary section is engaged in the proper ratio, the ECU will calculate or otherwise determine, and continue to update, an enabling range or band of input shaft speeds, based upon sensed output shaft (vehicle) speed and the ratio to be engaged, which will result in an acceptably synchronous engagement of the ratio to be engaged. As the operator, by throttle manipulation and/or use of the input shaft brake, causes the input shaft speed to fall within the acceptable range, the ECU 106 will issue command output signals to manifold 112 to cause actuator 70 to engage the mainsection ratio to be engaged. Preferably, the actuator will respond very quickly not requiring the operator to maintain the input shaft speed within the acceptable range for an extended period of time. To select a shift into transmission neutral, selection button 126 is pushed. Indicating light 116 will flash until the ECU confirms that neutral is obtained at which time the light 116 will assume a continuously lighted condition while the transmission remains in neutral.

In the automatic preselection mode of operation, selected by use of lighted pushbutton 122, the ECU will, based upon stored logic rules, currently engaged ratio (which may be calculated by comparing input shaft to output shaft speed) and output shaft or vehicle speed, determine if an upshift or a downshift is required and preselect same. The operator is informed that an upshift or downshift is preselected and will be semi-automatically implemented by a command output signal from ECU 106 causing either lighted pushbutton 120 or lighted pushbutton 124 to flash and/or an audible shift alert signal. The operator may initiate semi-automatic implementation of the automatically preselected shift as indicated above or may cancel the automatic mode and the shift preselected thereby by depression of pushbutton 122.

As an alternative, the neutral condition indication light 116 may be eliminated and neutral selection pushbutton 126 replaced by a lighted pushbutton.

An alternative driver control and display console 130 may be seen by reference to Figure 3. A joy stick 132 is movable against a resilient bias from its centered position to select upshifts, downshifts, a shift to neutral or the automatic preselect mode by movement up, down, leftward or rightward, respectively, as indicated. Indicia lights 134 and 136 are lighted to indicate an upshift or downshift, respectively, is preselected. Indicia lights 138 and 140, respectively, are lighted to indicate a vehicle forward or reverse, respectively, mode of operation. Indicia light 142 is steadily lighted to indicate a transmission neutral condition and is flashed to indicate a preselected but not yet confirmed neutral condition. Indicia light 144 is lighted to indicate system 104 is operating in the automatic preselection mode of operation.

If the control system (104), while in the automatic preselect mode of operation, is allowed to preselect upshifts or downshifts while vehicle speed (output shaft speed) is relatively constant or is not changing at least at a predetermined rate, the vehicle operator may not be attentive to the display console and an automatic shift into sustained neutral, resulting from an unnoticed automatic preselection of a gear change and a naturally occurring vehicle drive train torque reversal, may be unexpected and/or undesired which may be

annoying and/or detrimental to the vehicles performance.

To minimize and/or eliminate the occurrence of unintended/unexpected shifts to sustained neutral when operating in the automatic preselect mode of operation of the previously proposed semi-automatic shift implementation control system, the enhanced control method/system of the present invention is provided.

Figures 4 and 5 illustrate the enhanced control system/method 200 of the present invention in flow chart and graphical format. If the system 104 is in the automatic preselect mode of operation, the current vehicle (output shaft) speed (OS) and input shafts speed (IS) is sensed as well as the rate of change of output shaft speed (dOS/dt). Of course, in drive train lock-up conditions, IS should equal engine speed (ES) and OS should have a known relation to any monitored transmission shaft.

Values of two variable references are calculated as functions of input shaft speed. The first reference, REF-UP, is a value which dOS/dt must exceed to enable automatic preselection of an upshift. The second reference, REF-DN, is a value which must be greater than dOS/dt to enable automatic preselection of a downshift. Within a range of input shaft speeds, REF-UP decreases with increasing values of IS while REF-DN also decreases with increasing values of IS.

The sensed input shaft speed IS is compared to a minimum Upshift RPM 150 to determine if an upshift should be evaluated and to a maximum Downshift RPM 152 to determine if a downshift should be evaluated.

If an upshift is to be evaluated, i.e. input shaft speed (IS) exceeds the minimum Upshift RPM (about 1600 RPM for a typical heavy duty truck diesel engine), then the current output shaft acceleration (dOS/dt) is compared to REF-UP to determine if an automatic preselection of an upshift is allowable.

If a downshift is to be evaluated, i.e. input shaft speed (IS) is less than the maximum Downshift RPM (about 1300 RPM for a typical heavy duty truck diesel engine), then the current output shaft acceleration/deceleration (dOS/dt) is compared to REF-DN to determine if an automatic preselection of a downshift is allowable.

Output shaft (vehicle) acceleration and/or deceleration falling outside the range defined by REF-DN to REF-UP will occur at vehicle operating conditions under which the vehicle operator will expect automatic preselection of shifting to occur.

Referring to Figure 5, between input shaft speed (IS) values corresponding to the minimum Upshift RPM, 150, and the rated maximum RPM 154, (usually about 1800 RPM for a typical heavy duty diesel engine) the value of REF-UP decreases from a preselected maximum Up Accelerator value 156 to a minimum Up Acceleration value 158. At IS values greater than rated maximum RPM 154, the value of REF-UP remains at the minimum Up acceleration value 158.

In one typical example, the value of the Maximum and Minimum Up Acceleration Values, 156 and 158, are about 30 RPM/sec. and 10 RPM/sec., respectively.

Between input shaft speed (IS) values corresponding to the Maximum Downshift RPM 152 and a rated Minimum RPM 160, typically about 1050 RPM, the value of REF-DN increases (corresponding to decreasing deceleration of the input shaft) from a preselected Minimum Down Acceleration (corresponding to a maximum deceleration) 162 to a Maximum Down Acceleration (corresponding to minimum deceleration) 164. At IS values lower than Minimum RPM 160, the value of REF-DN remains at the Maximum Down Acceleration value 164.

In one typical example, the value of the Minimum and Maximum Down Acceleration Values, 162 and 164, are about -20 RPM/sec. and -80 RPM/sec., respectively.

By allowing shifts to be automatically preselected earlier (at lower IS for upshifts and higher IS for downshifts) in the presence of higher absolute values of change of vehicle speed, the control is, to a degree, load sensitive.

Accordingly, it may be seen that an enhanced control is provided for a relatively simple and inexpensive semi-automatic shift implementation control system (104)/method for a mechanical transmission system 10 having an automatic and preferably a manual preselect mode of operation and requiring only an ECU, a control console, a transmission shift actuator (112/70/96) and two speed inputs to be added to vehicle mechanical transmission system.

Claims

1. A control method (200) for controlling a vehicle automatic mechanical change gear transmission system comprising a solely manually fuel throttle controlled engine (E) having known characteristics, a multi-speed change gear mechanical transmission (10), a solely manually controlled master friction clutch (C) drivingly interposed between the engine and the transmission, a first sensor (98) for providing a first input signal (IS) indicative of transmission input shaft (16) rotational speed, a second sensor (100) for providing a second input signal (OS) indicative of the rotational speed of the transmission output shaft (90) under at least certain transmission operating conditions, a non-

manually controllable transmission actuator (112, 70, 96) for controlling shifting of the transmission, a mode selector (108) for manual selection of at least an automatic preselection mode of operation and for providing a mode input signal indicative of said selected mode, and a central processing unit (106) for receiving said input signals and for processing same in accordance with predetermined logic rules to issue command output signals, said central processing unit including means responsive to automatic preselection of a transmission shift from a currently engaged ratio for automatically issuing command output signals to said actuator to cause the transmission to be shifted into neutral;

said method comprising also:

predetermining as a function of said known characteristics of said engine a minimum upshift input shaft speed value (150), a rated maximum input shaft speed value (154), a maximum downshift input shaft speed value (160) and a rated minimum input shaft speed value (160);

if said central processing unit is operating in said automatic preselection mode of operation, sensing the rotational speed of said input shaft (IS) and of said output shaft (OS) and the rotational acceleration (dOS/dt) of said output shaft; and

calculating a first reference value (REF-UP) and a second reference value (REF-DN), characterized by said first reference value (REF-UP) decreasing in the range of input shaft speeds from said minimum upshift input shaft speed value (150) to said rated maximum input shaft speed value (154) and by said second reference value (REF-DN) increasing in the range of input shaft speeds from said maximum downshift input shaft speed value (152) to said rated minimum input shaft speed value (160); and by

preselecting upshifts only if sensed input shift speed exceeds said minimum upshift input shift speed value (150) and the rotational acceleration of said output shaft (dOS/dt) exceeds said first reference value (REF-UP) and preselecting downshifts only if sensed input shaft speed is less than said maximum downshift input shaft speed value (152) and the rotational acceleration of said output shaft (dOS/dt) is less than said second reference value (REF-DN).

2. The method of claim 1 wherein said first reference value (REF-UP) is substantially constant at input shaft speeds exceeding said rated maximum input shaft speed value.

3. The method of claim 1 wherein said second reference value (REF-DN) is substantially constant at input shaft speeds less than said rated minimum input shaft speed value.

4. The method of claim 2 wherein said second reference value (REF-DN) is substantially constant at input shaft speeds less than said rated minimum input shaft speed value.

5. A control system for a vehicular automatic mechanical transmission system of the type wherein the transmission is automatically shifted from an engaged ratio into neutral and is retained in said neutral condition pending manual system manipulations of master clutch and throttle by the vehicle operator, said system comprising:

means for predetermining, as a function of said known characteristics of an engine, a minimum upshift input shaft speed value (150), a rated maximum input shaft speed value (154), a maximum downshift input shaft speed value (160) and a rated minimum input shaft speed value (160);

means effective with said system operating in an automatic mode of operation, for sensing the rotational speed of the transmission input shaft (IS) and output shaft (OS) and the rotational acceleration of the transmission output shaft (dOS/dt); and the transmission shifting/nonshifting condition;

means for calculating as a function of input shaft speed a first reference value (REF-UP), characterized in that said first reference value (REF-UP) decreases in the range of input shaft speeds from said minimum upshift input shaft speed value (150) to said rated maximum input shaft speed value (154) and said second reference value (REF-DN) increases in the range of input shaft speeds from said maximum downshift input shaft speed value (152) to said rated minimum input shaft speed value (160); and by

means for preselecting upshifts only if sensed input shaft speed exceeds said minimum upshift input shift speed value (150) and the rotational acceleration of said output shaft (dOS/dt) exceeds said first reference value (REF-UP) and preselecting downshifts only if sensed input shaft speed is less than said maximum downshift input shaft speed value (152) and the rotational acceleration of said output shaft (dOS/dt) is less than said second reference value (REF-DN).

6. The system of claim 5 wherein said first reference value (REF-UP) is substantially constant at input shaft speeds exceeding said rated

maximum input shaft speed value.

7. The system of claim 5 or 6 wherein said second reference value (REF-DN) is substantially constant at input shaft speeds less than said rated minimum input shaft speed value.

Patentansprüche

1. Steuerverfahren (200) zum Steuern eines automatischen mechanischen Gangwechselgetriebesystems für Kraftfahrzeuge, mit einem allein vom Fahrer durch Gemisch- oder Kraftstoffzumessung gesteuerten Motor (E) mit bekannten Eigenschaften, mit einem mehrgängigen Gangwechselgetriebe (10), mit einer allein vom Fahrer gesteuerten Reibungshauptkupplung (C), die antriebsmäßig zwischen dem Motor und dem Getriebe angeordnet ist, mit einem ersten Sensor (98) zum Liefern eines Signales (IS), das die Drehzahl der Getriebeeingangswelle (16) kennzeichnet, mit einem zweiten Sensor (100), der ein zweites Eingangssignal (OS) liefert, das wenigstens unter gewissen Bebetriebsbedingungen des Getriebes die Drehzahl der Getriebeausgangswelle (90) kennzeichnet, mit einem nicht manuell steuerbaren Getriebeaktuator (112, 70, 96) zum Steuern des Schaltens des Getriebes, mit einem Betriebsartenauswahlschalter (108) zur manuellen Auswahl wenigstens einer Betriebsart mit automatischer Vorauswahl und zum Liefern eines Betriebsarten-Eingangssignales, das die ausgewählte Betriebsart kennzeichnet, und mit einer zentralen Verarbeitungseinheit (106) zum Empfangen von Eingangssignalen und zum Verarbeiten derselben gemäß vorbestimmter logischer Regeln, um Ausgangssignale auszugeben, wobei die zentrale Verarbeitungseinheit Mittel enthält, die von der automatischen Vorauswahl eines Getriebeschaltens aus einer gegenwärtig eingelegten Gangstufe heraus gesteuert sind, um automatisch Befehlsausgangssignale an den Aktuator auszugeben, um das Getriebe zu veranlassen, in den Leerlauf geschaltet zu werden;

wobei das Verfahren außerdem beinhaltet:

das Vorbestimmen eines minimalen Hochschalt-Eingangswellendrehzahlwertes (150) als eine Funktion der bekannten Eigenschaften des Motors, eines Eingangswellendrehzahlnennwertes (154), einer maximalen Zurückschalt-Eingangswellendrehzahl (160) und eines minimalen Eingangswellendrehzahlnennwertes (160);

wenn die zentrale Verarbeitungseinheit in der Betriebsart mit automatischer Vorauswahl arbeitet, werden die Drehzahl der Eingangswelle (IS) und der Ausgangswelle (OS) sowie die Drehbeschleunigung (dOS/dt) der Ausgangswelle erfaßt; und

das Berechnen eines ersten Referenzwertes (REF-UP) und eines zweiten Referenzwertes (REF-DN), dadurch gekennzeichnet, daß sich der erste Referenzwert (REF-UP) in dem Bereich der Eingangsdrehzahlen von dem minimalen Hochschalt-Eingangswellendrehzahlwert (150) zu dem maximalen Eingangswellendrehzahlnennwert (154) vermindert und daß sich der zweite Referenzwert (REF-DN) in dem Bereich der Eingangswellendrehzahlen von dem maximalen Zurückschalt-Eingangswellendrehzahlwert(152) zu dem minimalen Eingangswellendrehzahlnennwert (160) erhöht; und durch

die Vorauswahl von Hochschaltvorgängen nur dann, wenn die Eingangswellendrehzahl den minimalen Hochschalt-Eingangsdrehzahlwert (150) überschreitet und die Drehbeschleunigung der Ausgangswelle (dOS/dt) den ersten Referenzwert (REF-UP) überschreitet, und durch das Vorauswählen von Zurückschaltvorgängen nur dann, wenn die erfaßte Eingangswellendrehzahl geringer ist als der maximale Zurückschalt-Eingangswellendrehzahlwert (152) und wenn die Drehbeschleunigung der Ausgangswelle (dOS/dt) geringer ist als der zweite Referenzwert (REF-DN).

2. Verfahren nach Anspruch 1, bei dem der erste Referenzwert (REF-UP) bei Eingangswellendrehzahlen, die den maximalen Eingangswellendrehzahlnennwert überschreiten, im wesentlichen konstant ist.

3. Verfahren nach Anspruch 3, bei dem der zweite Referenzwert (REF-DN) bei Eingangswellendrehzahlen, die geringer sind als der minimale Eingangswellendrehzahlnennwert, im wesentlichen konstant ist.

4. Verfahren nach Anspruch 2, bei dem der zweite Referenzwert (REF-DN) bei Eingangswellendrehzahlen, die geringer sind als der minimale Eingangswellendrehzahlnennwert, im wesentlichen konstant ist.

5. Steuersystem für ein automatisches mechanisches Kraftfahrzeuggetriebesystem des Typs, bei dem das Getriebe aus einer eingelegten Gangstufe automatisch in den Leerlauf geschaltet und bei manueller Systembedienung durch die Hauptkupplung und das Fahrpedal durch den Fahrer in dem Leerlaufzustand gehalten wird, wobei das System enthält:

Mittel, um als eine Funktion der bekannten

Eigenschaften eines Motors einen minimalen Eingangswellendrehzahlwert (150) für das Hochschalten, einen maximalen Eingangswellendrehzahlnennwert (154), einen maximalen Eingangswellendrehzahlwert (160) zum Zurückschalten und einen minimalen Eingangswellendrehzahlnennwert (160) vorauszuwählen;

Mittel, die bei in automatischer Betriebsart arbeitendem System dazu dienen, die Drehzahl der Getriebeeingangswelle (IS) und der Getriebeausgangswelle (OS) sowie die Drehbeschleunigung der Getriebeausgangswelle (dOS/dt) sowie den Getriebeschalt/Nichtschalt-Zustand zu bestimmen;

Mittel zum Berechnen eines ersten Referenzwertes (REF-UP) als eine Funktion der Eingangswellendrehzahl, dadurch gekennzeichnet, daß sich der erste Referenzwert (REF-UP) in dem Bereich der Eingangswellendrehzahlen von dem minimalen Eingangswellendrehzahlwert (150) zum Hochschalten zu dem maximalen Eingangswellendrehzahlnennwert (154) vermindert, und daß sich der zweite Referenzwert (REF-DN) in dem Bereich der Eingangswellendrehzahlen zu dem maximalen Eingangswellendrehzahlnennwert (152) zum Zurückschalten zu dem minimalen Eingangswellendrehzahlnennwert (160) erhöht; und durch

Mittel zum Vorausauswählen eines Hochschaltens nur dann, wenn die erfaßte Eingangswellendrehzahl den maximalen Eingangswellendrehzahlnennwert (150) für das Hochschalten überschreitet und wenn die Drehbeschleunigung der Ausgangswelle (dOS/dt) den ersten Referenzwert (REF-UP) überschreitet, und zum Vorauswählen von Zurückschaltvorgängen nur dann, wenn die erfaßte Eingangswellendrehzahl geringer ist als der maximale Eingangswellendrehzahlnennwert (152) zum Zurückschalten und wenn die Drehbeschleunigung der Ausgangswelle (dOS/dt) geringer ist als der zweite Referenzwert (REF-DN).

6. System nach Anspruch 5, bei dem der erste Referenzwert (REF-UP) bei Eingangswellendrehzahlen, die den maximalen Eingangswellendrehzahlnennwert überschreiten, im wesentlichen konstant ist.

7. System nach Anspruch 5 oder 6, bei dem der zweite Referenzwert (REF-DN) bei Eingangswellendrehzahlen, die geringer sind als der minimale Eingangswellendrehzahlnennwert, im wesentlichen konstant ist.

Revendications

1. Procédé de commande (200) pour commander un système de transmission mécanique automatique de véhicule, comprenant un moteur (E) commandé uniquement manuellement au moyen d'un papillon des gaz et possédant des caractéristiques connues, une transmission mécanique à vitesses multiples (10), un embrayage à friction maître (C) commandé uniquement manuellement et intercalé, selon une liaison motrice, entre le moteur et la transmission, un premier capteur (98) servant à délivrer un premier signal d'entrée (IS) indicatif de la vitesse de rotation de l'arbre d'entrée (16) de la transmission, un second capteur (100) servant à délivrer un second signal d'entrée (OS) indicatif de la vitesse de rotation de l'arbre de sortie (90) de la transmission dans au moins certaines conditions de fonctionnement de la transmission, un actionneur (112, 70,96) de la transmission pouvant être commandé d'une manière non manuelle et servant à commander le changement de vitesse de la transmission, un sélecteur de mode (108) pour la sélection manuelle d'au moins un mode de sélection automatique de fonctionnement et pour la délivrance d'un signal d'entrée de mode indicatif dudit mode sélectionné, et une unité centrale de traitement (106) pour recevoir lesdits signaux d'entrée et traiter ces derniers en fonction de règles logiques prédéterminées pour la délivrance de signaux de sortie de commande, ladite unité centrale de traitement comprenant des moyens aptes à répondre à une présélection automatique d'un changement de vitesse dans la transmission depuis un rapport actuellement engagé pour la délivrance automatique de signaux de sortie de commande audit actionneur de manière à faire passer la transmission dans la position neutre;

ledit procédé comprenant également :

la prédétermination, en tant que fonction desdites caractéristiques connues dudit moteur, d'une valeur minimale (150) de la vitesse de l'arbre d'entrée de passage à une vitesse supérieure, une valeur nominale maximale (154) de la vitesse de l'arbre d'entrée, une valeur maximale (160) de la vitesse de l'arbre d'entrée de passage à une vitesse inférieure et une valeur nominale minimale (160) de la vitesse de l'arbre d'entrée;

si ladite unité centrale de traitement fonctionne dans le mode de fonctionnement à présélection automatique la détection de la vitesse de rotation dudit arbre d'entrée (IS) et dudit arbre de sortie (OS) et l'accélération en rotation (DOS/dt) dudit arbre de sortie;

le calcul d'une première valeur de référence (REF-UP) et d'une seconde valeur de référence (REF-DN);

caractérisé en ce que ladite première valeur de référence (REF-UP) diminue dans la gamme des vitesses de l'arbre d'entrée depuis ladite valeur minimale (150) de la vitesse de l'arbre d'entrée de passage à une vitesse supérieure jusqu'à ladite valeur maximale nominale (151) de la vitesse de l'arbre d'entrée, et en ce que ladite seconde valeur de référence (REF-DN) augmente dans la gamme de vitesses de l'arbre d'entrée depuis ladite valeur maximale (154) de la vitesse de l'arbre d'entrée de passage à une vitesse inférieure à ladite valeur nominale minimale (160) de la vitesse de l'arbre d'entrée; et

par la présélection de passages à des vitesses supérieures uniquement si la vitesse détectée de l'arbre d'entrée dépasse ladite valeur minimale (105) de la vitesse de l'entrée de passage à une vitesse supérieure et si l'accélération en rotation dudit arbre de sortie (dOS/dt) dépasse ladite première valeur de référence (REF-UP), et par la présélection de passages à des vitesses inférieures uniquement si la vitesse détectée de l'arbre d'entrée est inférieure à ladite valeur maximale (152) de la vitesse de l'arbre d'entrée de passage à une vitesse inférieure, et si l'accélération en rotation dudit arbre de sortie (dOS/dt) est inférieure à ladite seconde valeur de référence (REF-DN).

2. Procédé selon la revendication 1, selon lequel ladite première valeur de référence (REF-UP) est essentiellement constante à des vitesses de l'arbre d'entrée dépassant ladite valeur nominale maximale de la vitesse de l'arbre d'entrée.

3. Procédé selon la revendication 1, selon lequel ladite seconde valeur de référence (REF-DN) est essentiellement constante pour des vitesses de l'arbre d'entrée inférieures à ladite valeur nominale minimale de l'arbre d'entrée.

4. Procédé selon la revendication 2, selon lequel ladite seconde valeur de référence (REF-DN) est essentiellement constante pour des vitesses de l'arbre d'entrée inférieures à ladite valeur nominale minimale de la vitesse de l'arbre d'entrée.

5. Système de ocmamnde pour un système de transmission mécanique automatique de véhicule du type dans lequel la transmission est commutée automatiquement d'un rapport engagé à la position neutre et est maintenu dans ladite position neutre au cours d'actionnements manuels du système de l'embrayage maître et du papillon des gaz par le conducteur du véhicule, ledit système comprenant :

des moyens pour prédéterminer, en fonction desdites caractéristiques connues d'un moteur, une valeur minimale (150) de la vitesse de l'arbre d'entrée de passage à une vitesse supérieure, une valeur nominale maximale (154) de la vitesse de l'arbre d'entrée, une valeur maximale (160) de la vitesse de l'arbre d'entrée de passage à une vitesse inférieure et une valeur nominale minimale (160) de la vitesse de l'arbre d'entrée;

des moyens agissant avec ledit système fonctionnant dans un mode de fonctionnement automatique, pour détecter la vitesse de rotation de l'arbre d'entrée (IS) de la transmission et de l'arbre de sortie (OS) de la transmission et l'accélération en rotation de l'arbre de sortie (dOS/dt) de la transmission; et l'état de changement de vitesse/d'absence de changement de vitesse dans la transmission;

des moyens pour calculer, en fonction de la vitesse d'entrée de l'arbre, une première valeur de référence (REF-UP),

caractérisé en ce que ladite première valeur de référence (REF-UP) diminue dans la gamme de vitesses de l'arbre d'entrée allant de ladite valeur minimale (150) de la vitesse de l'arbre d'entrée de passage à une vitesse supérieure à ladite valeur nominale maximale (154) de la vitesse de l'arbre d'entrée, et que ladite seconde valeur de référence (REF-DN) augmente dans la gamme de vitesses de l'arbre d'entrée allant de ladite valeur maximale (150) de la vitesse de l'arbre d'entrée de passage à une vitesse inférieure à ladite valeur nominale minimale (160) de la vitesse de l'arbre d'entrée; et

par des moyens pour présélectionner des passages à des vitesses supérieures uniquement si la vitesse détectée de l'arbre d'entrée dépasse ladite valeur minimale (150) de la vitesse de l'arbre d'entrée de passage à une vitesse supérieure et l'accélération en rotation dudit arbre de sortie (dOS/dt) dépasse ladite première valeur de référence (REF-UP), et par la présélection de passage à des vitesses inférieures uniquement si la vitesse détectée de l'arbre d'entrée est inférieure à ladite valeur maximale (152) de la vitesse de l'arbre d'entrée de passage à une vitesse inférieure, et si l'accélération en rotation dudit arbre de sortie (dOS/dt) est inférieure à ladite seconde valeur de référence (REF-DN).

6. Système selon la revendication 5, dans lequel ladite première valeur de référence (REF-UP) est essentiellement constante pour des vitesses de l'arbre d'entrée qui dépassent ladite valeur nominale maximale de la vitesse de l'arbre d'entrée.

7. Système selon la revendication 5 ou 6, dans lequel ladite seconde valeur de référence (REF-DN) est essentiellement constante pour des vitesses de l'arbre d'entrée inférieures à ladite valeur nominale minimale de la vitesse de l'arbre d'entrée.

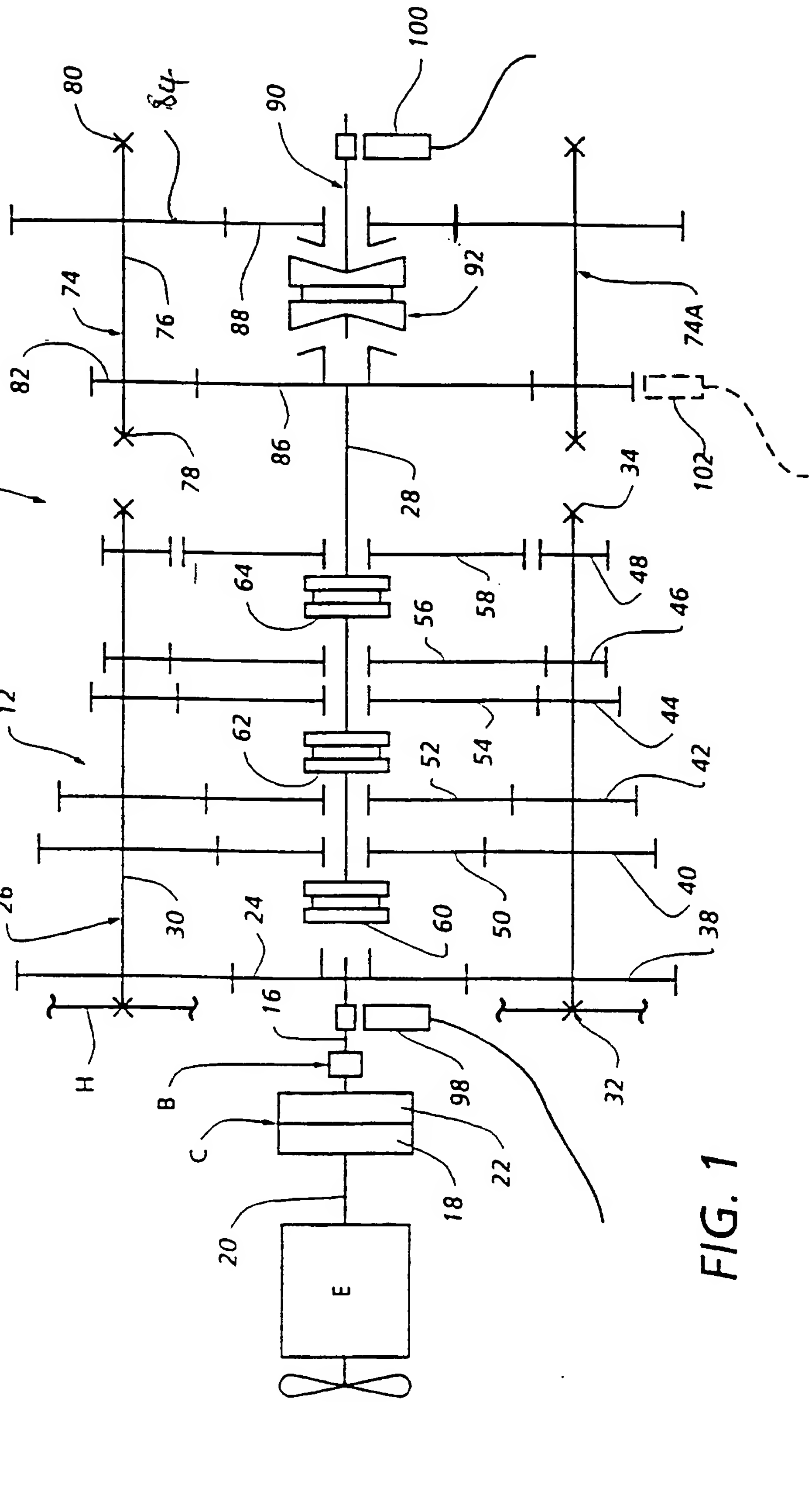
14
10
12
80
84
90
100
74
76
88
92
82
86
78
74A
102
34
28
64
58
48
56
46
62
52
54
44
42
26
30
24
60
50
40
38
16
H
B
C
98
32
18
22
20
E

FIG. 1

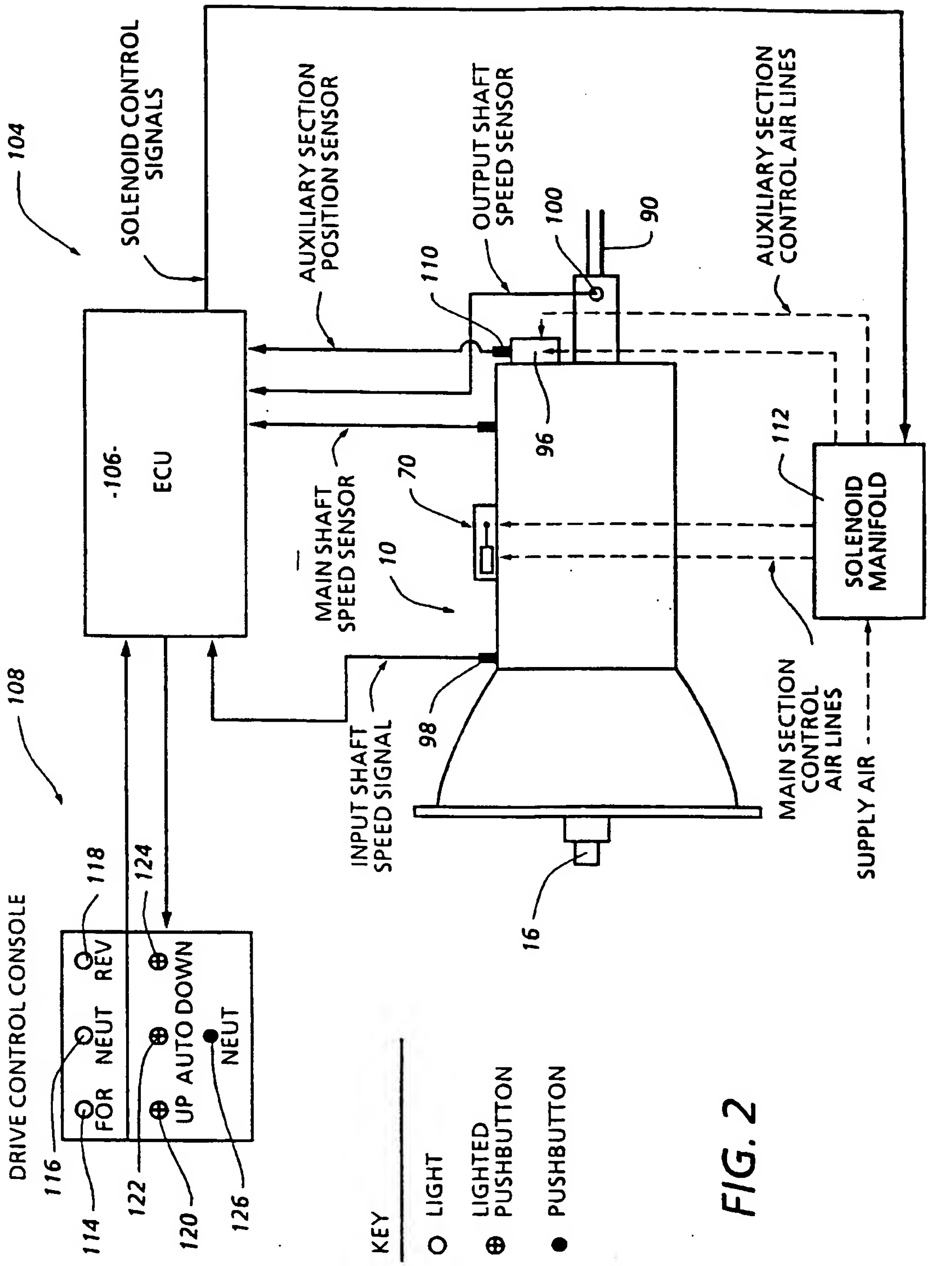
104
SOLENOID CONTROL SIGNALS
AUXILIARY SECTION POSITION SENSOR
OUTPUT SHAFT SPEED SENSOR
AUXILIARY SECTION CONTROL AIR LINES
110
100
90
-106-
ECU
96
112
70
SOLENOID MANIFOLD
MAIN SHAFT SPEED SENSOR
10
108
98
INPUT SHAFT SPEED SIGNAL
MAIN SECTION CONTROL AIR LINES
SUPPLY AIR
16
DRIVE CONTROL CONSOLE
118
124
FOR
NEUT
REV
UP
AUTO
DOWN
NEUT
116
114
122
120
126
KEY
LIGHT
LIGHTED PUSHBUTTON
PUSHBUTTON

FIG. 2

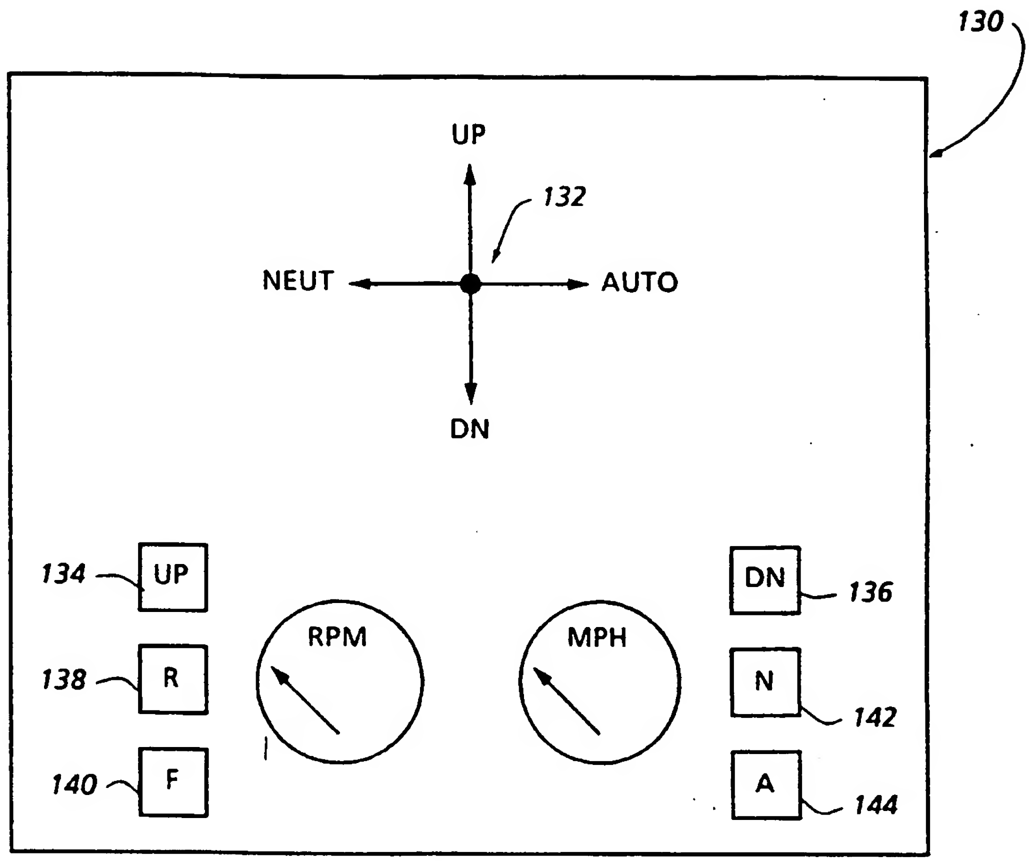
130
UP
132
NEUT
AUTO
DN
134
UP
138
R
140
F
RPM
MPH
DN
136
N
142
A
144

FIG. 3

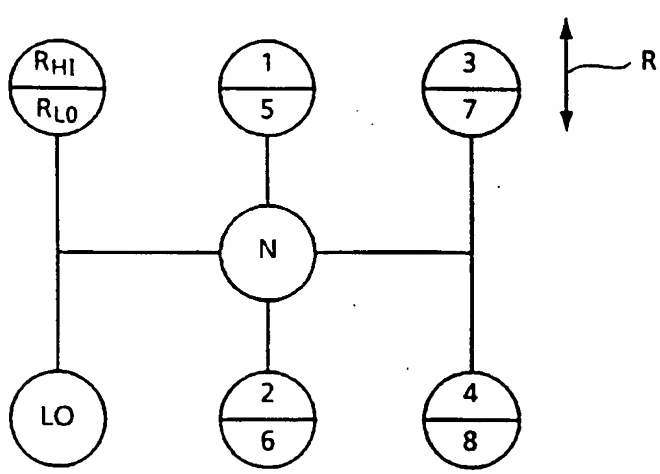
RHI
RLO
1
5
3
7
R
N
LO
2
6
4
8

FIG. 1A

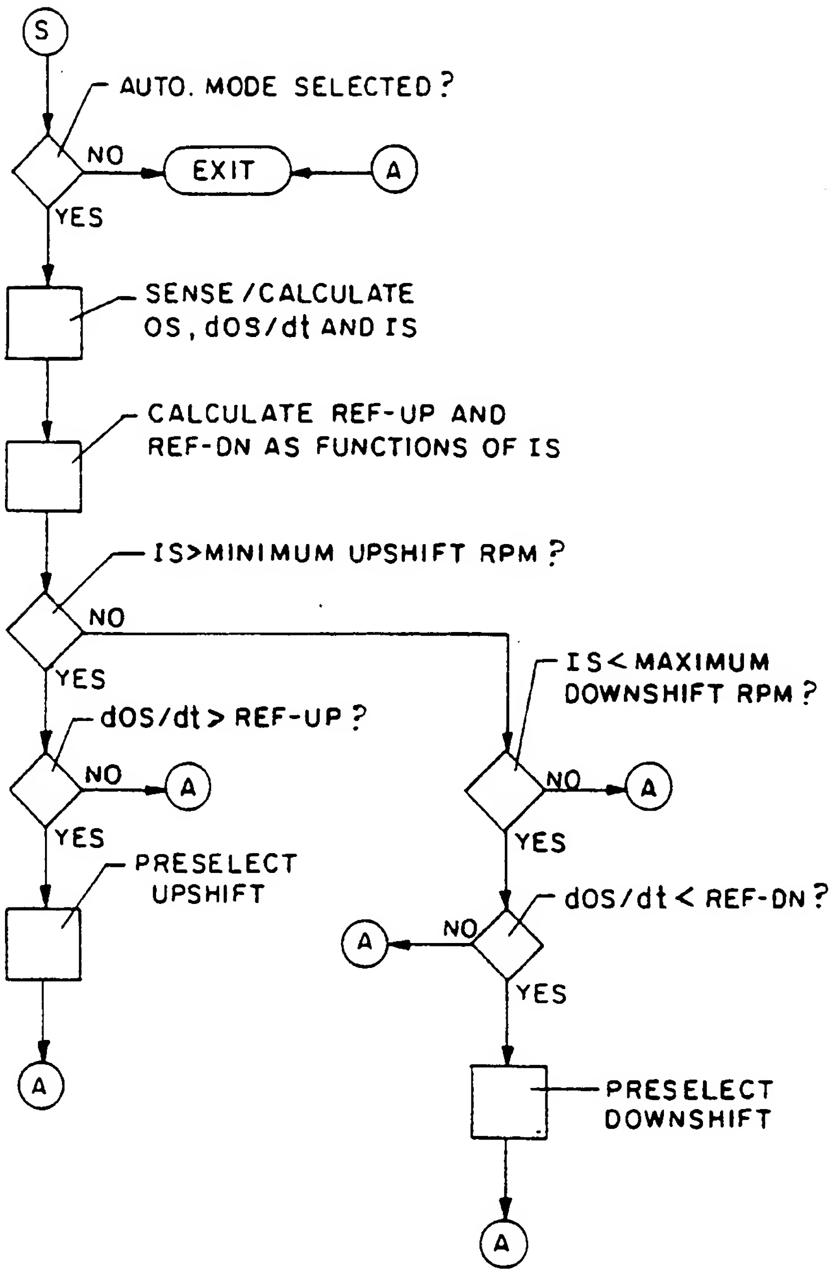
S
AUTO. MODE SELECTED ?
NO
EXIT
A
YES
SENSE / CALCULATE
OS, dOS/dt AND IS
CALCULATE REF-UP AND
REF-DN AS FUNCTIONS OF IS
IS>MINIMUM UPSHIFT RPM ?
NO
YES
IS<MAXIMUM
DOWNSHIFT RPM ?
dOS/dt > REF-UP ?
NO
A
YES
NO
A
YES
PRESELECT
UPSHIFT
dOS/dt < REF-DN ?
A
NO
YES
A
PRESELECT
DOWNSHIFT
A

FIG. 4

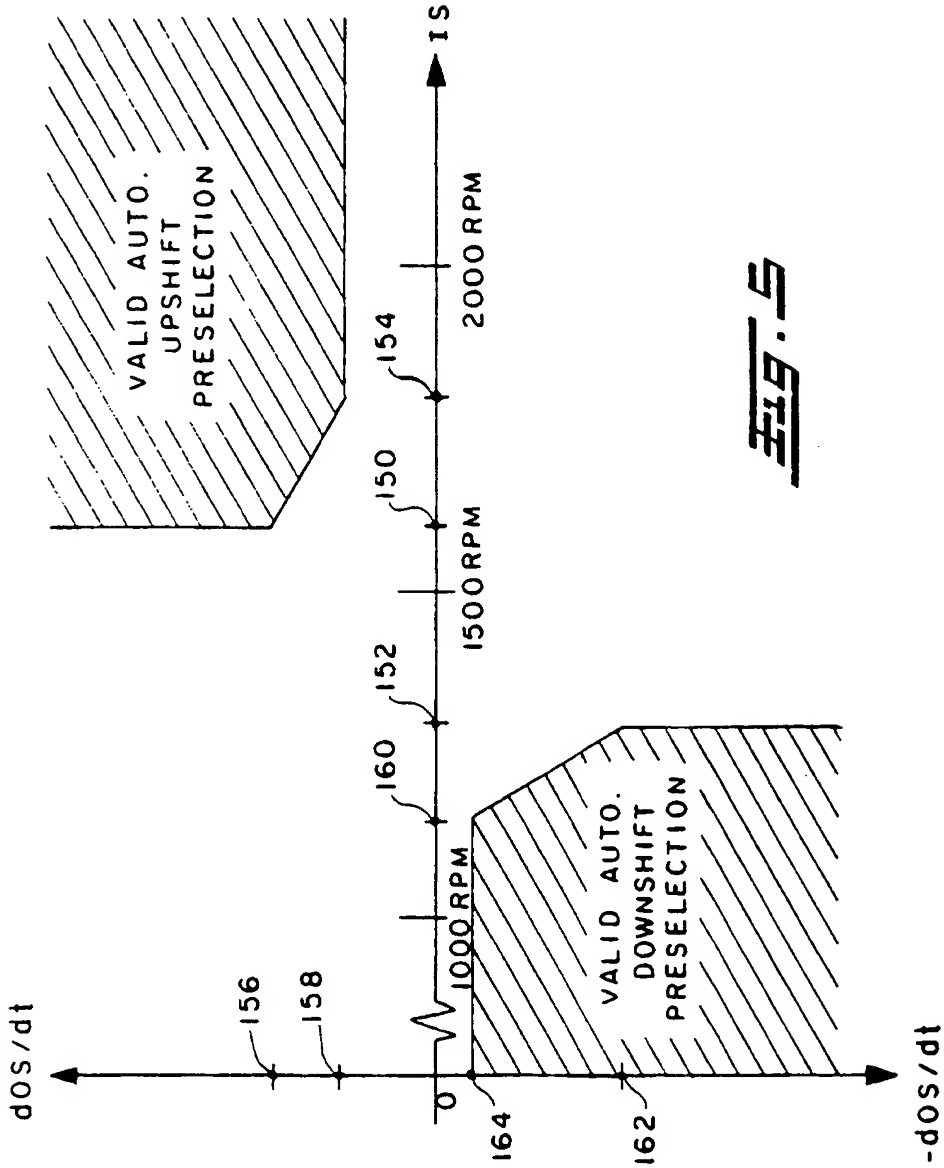
VALID AUTO.
UPSHIFT
PRESELECTION
VALID AUTO.
DOWNSHIFT
PRESELECTION
IS
2000 RPM
1500 RPM
1000 RPM
154
150
152
160
156
158
164
162
0
dOS/dt
-dOS/dt

FIG. 5